rubino
ENGINEERING INC.

REPORT TRANSMITTAL

April 16th, 2018

To: Thomas Paolicchi, PE, LEED AP BD+C
ABNA Engineering, Inc.
9901 South Western Ave., Suite 001
Chicago, IL 60643
Phone: 773.881.4788 x 1115
Mobile: 773.239.3728
Fax: 773.972.8060

Re: **Roadway Geotechnical Report (RGR)**
IL Route 132 Dry Land Bridge Roadway Improvements
Cleveland Avenue to McKinley Avenue
Lake County, Illinois
PTB 175-06
Route: F.A.P. Route 541 IL Rte 132
Section: WR (2) – R - 1
June 2018 Letting

Rubino Project No. G16.099

Via email: TPaolicchi@abnacorp.com

Dear Mr. Paolicchi,

Rubino Engineering, Inc. (Rubino) is pleased to submit our Roadway Geotechnical Report (RGR) for the roadway improvements that are a part of the IL Route 132 Dry Land Bridge project in Lake Villa, Illinois.

Report Description

Enclosed is the RGR including results of field and laboratory testing, as well as recommendations for subgrade preparation and stability.

Authorization and Correspondence History

- ABNA Engineering, Inc. (ABNA) Phase II Agreement for Subconsultant Services; dated August 10th, 2016.
- October 12, 2017 IDOT District One project meeting with IDOT, ABNA, and Rubino resulted in request for additional investigations and separate RGR.

Closing

Rubino appreciates the opportunity to provide geotechnical services for this project and we look forward to continued participation during the design and in future construction phases of this project. If you have questions pertaining to this report, or if Rubino may be of further service, please contact our office at (847) 931-1555.

Respectfully submitted,
RUBINO ENGINEERING, INC.

Michelle A. Lipinski, PE
President
Phone: (847) 931-1555 x 12
Email: michelle.lipinski@rubinoeng.com
MAL/file/ Enclosures

IL ROUTE 132 DRY LAND BRIDGE
ROADWAY IMPROVEMENTS

CLEVELAND AVENUE TO MCKINLEY AVENUE
LAKE COUNTY, ILLINOIS

ROUTE: F.A.P. ROUTE 541 (IL RTE 132)
SECTION: WR(2) – R – 1
CONTRACT: 62A53

JUNE 2018 LETTING

Roadway Geotechnical Report

{ *RGR* }

PREPARED BY:

rubino ENGINEERING INC.

Michelle A. Lipinski, PE
President
IL No. 062-061241, Exp. 11/30/19
Phone: (847) 931-1555 x 12
Email:michelle.lipinski@rubinoeng.com

PREPARED FOR:

ABNA ENGINEERING, INC.

9901 SOUTH WESTERN AVE., SUITE 001

CHICAGO, ILLINOIS

RUBINO PROJECT NO. G16.099 REV 1

April 16th, 2018

TABLE OF CONTENTS

PROJECT INFORMATION

Introduction and Project Description

Rubino Engineering, Inc. (Rubino) understands that the Illinois Department of Transportation (IDOT) is planning to improve IL 132 between McKinley Avenue and Oak Lane Drive to a three-lane cross section, including widening the existing dry land bridge as well as roadway improvements on both ends of the structure extending from Cleveland Avenue to McKinley Avenue with assistance from ABNA Engineering, Inc. (ABNA). See Rubino's Structural Geotechnical Report (SGR) Revision 3 for additional project details.

Documents received:

- "IL 132 – Oak Lane Dr. to McKinley Ave. Plan and Profile" – prepared by State of Illinois Department of Transportation dated June 13th, 2013:
- IDOT Phase I Report Approval – IL 132 / Grand Ave
- "IL 132 – Final Project" – prepared by State of Illinois Department of Transportation dated October 2014 (see excerpts below).
- TS&L Sheets 1 to 5 - Prepared by ABNA Dated April 17, 2017
- TS&L Sheets 1 to 5 - Prepared by ABNA Dated September 5, 2017
- "IL 132 (Grand Ave.) – Oak Lane Dr. to McKinley Dr. Roadway Plan and Profile" Sheets 16 to 20 – prepared by ABNA dated June 26, 2017
- "IL 132 (Grand Ave.) – Oak Lane Dr. to McKinley Dr. Cross Sections" Sheets XS001 to XS011 – prepared by ABNA not dated by sent via email October 17, 2017

Project Correspondence:

- RFP Email from Thomas Paolicchi of ABNA Engineering, Inc. (ABNA) on May 28th, 2015.
- IL 132 Land Bridge Structural Geotechnical Report (SGR) submitted to ABNA on March 13th, 2017.
- IL 132 Land Bridge Structural Geotechnical Report Addendum 1 submitted to ABNA on August 28th, 2017.
- "Structural Geotechnical Report (SGR) Review Speed Letter 049-0690" prepared by Patrick D. Claussen of the IDOT dated September 8th, 2017.
- IL 132 Land Bridge Structural Geotechnical Report (SGR) Revision 1 submitted to ABNA on September 22nd, 2017.

- Project meeting at IDOT District One Office on October 12th, 2017 between IDOT, ABNA, and Rubino. Meeting Minutes prepared by ABNA on October 20th, 2017.
- "IL Rte 132 Dry Land Bridge SN 049-0690" review email prepared by Luke T. Murphy of the IDOT Bureau of Bridges and Structures (BBS) dated October 13th, 2017.
- IL 132 Dry Land Bridge Structural Geotechnical Report (SGR) Revision 2 submitted to ABNA on November 8th, 2017.
- "FAP 541 (IL Route 132) from Cleveland Ave to McKinley Ave" review memorandum of the draft RGR prepared by Giancarlo Gierbolini of IDOT dated March 12, 2018.

The geotechnical recommendations presented in this report are based on the available project information and the subsurface materials described in this report. If any of the information on which this report is based is incorrect, please inform Rubino in writing so that we may amend the recommendations presented in this report (if appropriate, and if desired by the client). Rubino will not be responsible for the implementation of our recommendations if we are not notified of changes in the project.

PROJECT LOCATION

Site Location and Description

F.A.P. Route 541 (IL RTE 132) is located in Lake Villa, Illinois within Lake County. The project generally spans from Cleveland Avenue to McKinley Avenue and the RGR portion includes the following limits:

IL Route 132 from 90 feet West of Cleveland Avenue to 70 feet East of Oak Lane Drive:

- Western Project Limit Latitude / Longitude (West of Cleveland Avenue): 42°24'55.73"N / 88° 5'17.53"W
- Eastern Project Limit Latitude / Longitude (East of Oak Lane Drive): 42°24'55.46"N / 88° 5'11.76"W

IL Route 132 from 130 feet West of Cedar Avenue to 40 feet East of McKinley Avenue:

- Western Project Limit Latitude / Longitude (West of Cedar Avenue): 42°24'55.78"N / 88° 4'57.81"W
- Eastern Project Limit Latitude / Longitude (McKinley Avenue): 42°24'55.76"N / 88° 4'47.02"W

The map below shows the general site location of where the soil borings were performed:

PROJECT SCOPE

Purpose / Scope of Services

The project includes roadway improvements on IL Route 132 in Lake Villa, Illinois for a stretch of road approximately 2,200 in length. The roadway is two-lanes for a total roadway width of approximately 25 feet and transitions at the far east end of the project limits to 32 feet including middle yellow striping. The roadway includes a dry land bridge structure spanning a compressible peat deposit adjacent to Cedar Lake. The RGR portion of the project is approximately 1,220 feet and the land bridge is 980 feet in length. Improvements include complete replacement of the pavement section and the deep foundation piles for the bridge structure. A third land will be added along the bridge structure.

The RGR portion of the project included drilling six (6) soil borings for geotechnical purposes. Rubino's scope of services included the following drilling program:

Table 1: Drilling Scope

BORING NUMBER	DEPTH (FEET BEG*)	EXISTING SURFACE ELEVATION (FEET)	LOCATION
SB-03	10	793.90	West of Cedar Ave to McKinley Avenue
SB-04	10	800.10	West of Cedar Ave to McKinley Avenue
SB-05	10	795.90	West of Cedar Ave to McKinley Avenue
SB-06	10	799.00**	Cleveland Avenue to Oak Lane Drive
SB-07	20	792.00**	Cleveland Avenue to Oak Lane Drive
SB-08	10	799.00**	West of Cedar Ave to McKinley Avenue

*BEG = below existing grade
**Existing elevations estimated using Google Earth

Representative soil samples obtained during the field exploration program were transported to the laboratory for additional classification and laboratory testing.

This report briefly outlines the following:

- *Summary of client-provided project information and report basis*
- *Overview of encountered surface and subsurface conditions*
- *Overview of site geology*
- *Overview of field and laboratory tests performed including results*
- *Geotechnical recommendations pertaining to:*
  - *Subgrade preparation, subgrade stability, and support rating recommendations*
- *Construction Considerations*

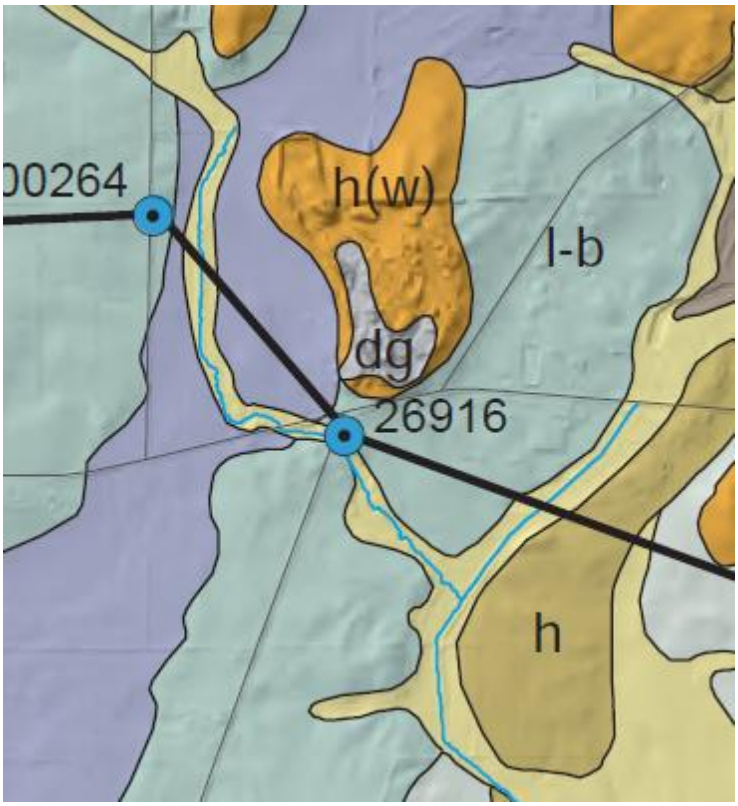
GEOLOGY AND PEDOLOGY

Geologic time scales indicating when rock or soil was formed are divided into four (4) eras: Cenozoic (recent life), Mesozoic (middle life), Paleozoic (ancient life) and Precambrian (earliest known). Cenozoic represents present time to 62 million years ago, Mesozoic – 62 to 230 million years, Paleozoic – 230 to 600 million years and Precambrian – 600 to 2500 million years ago. These eras are divided into systems of periods, which are further broken into epochs. Research has identified the rock and soils from these epochs and classified them into formations which are identifiable units of soil or rock having similar characteristics and origin. Formations are grouped together because the soil or rock has the same origin.

Unconsolidated material (soil) is classified as material deposited in the Cenozoic era and specifically the Pleistocene epoch (most recent). The soils in northern Illinois consist of surficial deposits that

were placed during the Pleistocene epoch. This geologic period represents the most recent time when glaciers gradually spread out over North America, scoured the earth and transported and deposited soil with various mechanisms. Warning climatic conditions slowly melted the glaciers and caused them to retreat to their present locations. These complex geologic processes have resulted in the present soil deposits of the Northeastern Illinois area and at the project location.

A review of the Illinois State Geological Survey Surficial Geology of Kane County (2013) reveals that soils in this area appear to be mostly from the Wisconsin Episode glaciation (~29,000 – 14,700 years before present). The soils present in the area are the Cahokia Formation, Equality Formation, Henry Formation, Henry Formation (Wasco Facies), and Batestown Member of the Lemont Formation. The Cahokia Formation consists of well-sorted alluvial sand and gravel with lenses of peat deposited within Lake Run Creek's stream bed and floodplain. The Cahokia tends to grade laterally to organic silt and clay containing small fossils. The Equality Formation is lake deposited gray to brown silt, clay, and fine sand from postglacial kettles and proglacial slackwater lakes in tributary valleys. The Henry Formation is comprised of sand and/or gravel with brown to gray silt and clay lenses deposited during proglacial outwash. The Henry Formation (Wasco Facies) contains mostly sand and gravel with some silt and loam deposited from the collapse of sediment during the melting of glacial ice (kamic deposits). Lastly, the Batestown Member, Lemont Formation consists of gray to brown sandy loam to loam with cobbles and sand and gravel layers. This member was deposited by glacial till and debris flows.



HUDSON EPISODE (~14,700 years before present [B.P.] to today)

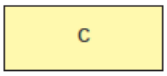
Fill (disturbed earth material); primarily material reworked from underlying deposits

Disturbed ground

Disturbed land; embankments and mounds (gray); pits and quarries (open diagonal lines with underlying unit showing through)

Sand and gravel, well-sorted sand, and lenses of peat, grading laterally to organic-rich silt and clay with fossil wood, moss, snails, ostracodes, and rootlets in most places; as much as 30 feet thick in the Fox River valley; generally less than 10 feet thick in smaller upland valleys

Cahokia Formation

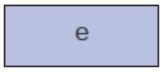


Alluvium in modern floodplains; overbank point bar and channel deposits

HUDSON EPISODE (~14,700 B.P. to today) and WISCONSIN EPISODE: Michigan Subepisode (~29,000–14,700 years B.P.)

Silt, clay, and fine sand; gray to brown; layered to massive; with fossil wood fragments, moss, gastropod shells, ostracodes, leaves, and rootlets in many places; surficial deposits are generally less than 20 feet thick

Equality Formation

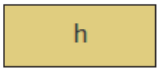


Lake deposits in postglacial kettles, and proglacial slackwater lakes in valleys tributary to the Fox River

WISCONSIN EPISODE: Michigan Subepisode (~29,000–14,700 years B.P.)

Sand and gravel, or sand; with lenses of silt and clay, or diamicton; yellowish brown, brown to gray; generally stratified

Henry Formation



Proglacial outwash forming terraces along major rivers and streams; outwash deposited in deltas and alluvial fans in stagnating ice environments

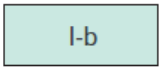
Sand and gravel (silty to clean), and sand with some beds of silt, and loam diamicton; stratified to laminated; contorted and faulted bedding; yellowish brown to grayish brown; as much as 160 feet thick

Henry Formation (Wasco facies)

Kamic (ice-contact) deposits; complex structure due to collapse of sediment during melting of ice

Diamicton; sandy loam to loam with abundant cobbles; friable; gray to grayish brown, oxidizing to yellowish brown to brown; includes common layers of sand and gravel, and stringers of silt and fine sand; as much as 65 feet thick

Batestown Member, Lemont Formation



Till and debris flow deposits, associated with the Gilberts Drift in western half of quadrangle

FIELD EXPLORATION

Drilling, Field, and Laboratory Test Procedures

Three (3) roadway borings were performed in September of 2016 (SB-03, SB-04, & SB-05) as part of an original drilling scope for the Land Bridge SGR. Two (2) original proposed borings (SB-01 & SB-02) were never performed due to utility conflicts. Furthermore, SB-04 was drilled approximately 40-feet south of the roadway due to utility conflicts. Three (3) additional roadway borings (SB-06, SB-07, & SB-08) were requested to supplement the information and data for roadway improvements and were drilled in December of 2017. The 2017 borings have not been surveyed and therefore station numbers and elevations have been estimated using plan and profile drawings, field observations, and Google Earth.

Rubino selected the boring locations and depths. Rubino located the borings in the field by using a Garmin GPSMap 64s and a Google Earth KMZ file. The borings were advanced utilizing 3 ¼ inch inside-diameter, hollow stem auger drilling methods and soil samples were routinely obtained during the drilling process.

Selected soil samples were tested in the laboratory to determine material properties for this report. Drilling, sampling, and laboratory tests were performed in general accordance with IL Modified AASHTO procedures. The following items are further described in the Appendix of this report.

- *Field Penetration Tests and Split-Barrel Sampling of Soils*
- *Water Level Measurements*
- *Laboratory Determination of Water (Moisture) Content of Soil by Mass*
- *Grain Size Analysis*
- *Organic Content by Loss on Ignition*

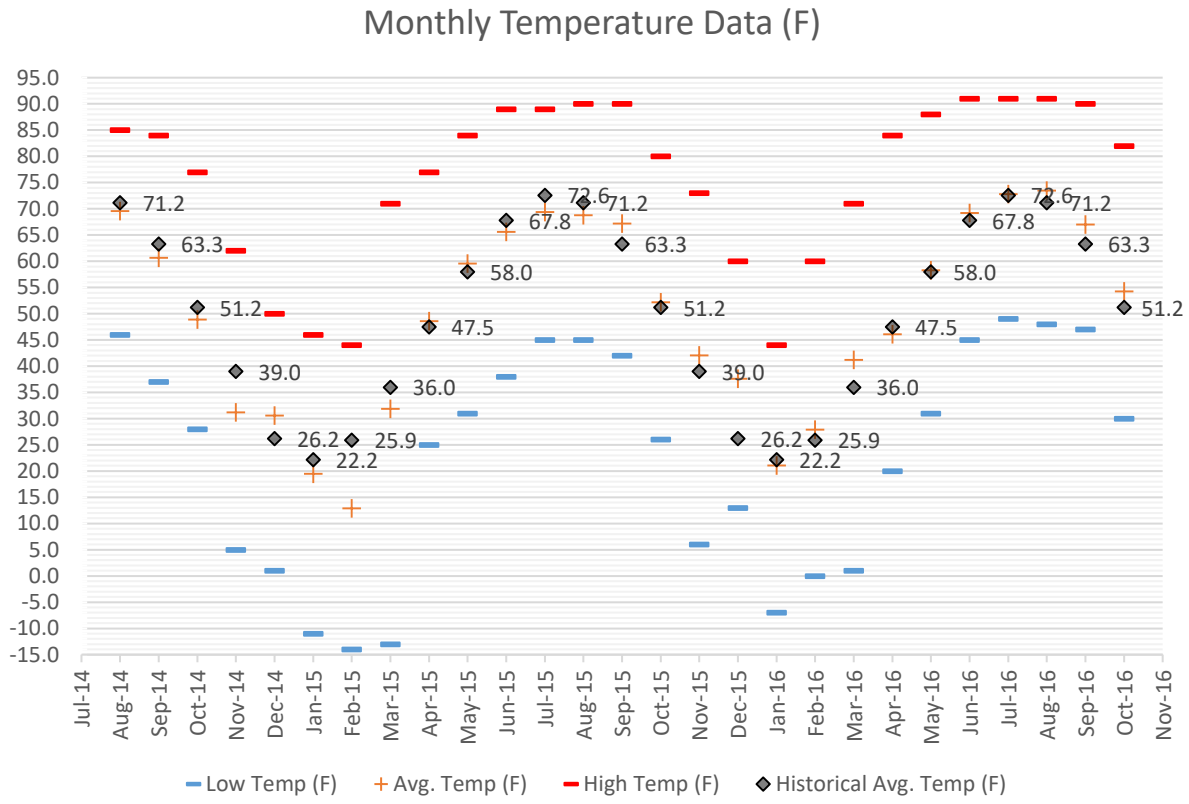
The results of the laboratory tests are to be found on the accompanying boring logs or within the Laboratory Tests Appendix.

The project site is adjacent to a natural lake, Lake Cedar, and the terrain within the project limits is generally flat. The bridge structure and adjacent lake lie at a low point in the surrounding topography and the roadway begins to climb a gentle grade at both the east and west end of the project limits. Surficial erosion was not directly observed as most of the property to the south is developed and a corn field sitting atop the compressible peat layers lies directly to the north between the roadway and the lake. Surface water on the roadway is managed by adjacent roadway ditches for the majority of the project limits with a section of curb, gutter, and storm sewer on the north side of the road east of the bridge.

Climatic Conditions

The initial subsurface investigation for the proposed IL 132 Dry Land Bridge in Lake Villa, Illinois was performed during the months of September and October 2016. To assess the possible effects of temperature and precipitation on groundwater level and soil moisture, the climatic conditions for the investigation period and several years prior to the start of the investigation are summarized graphically, below.

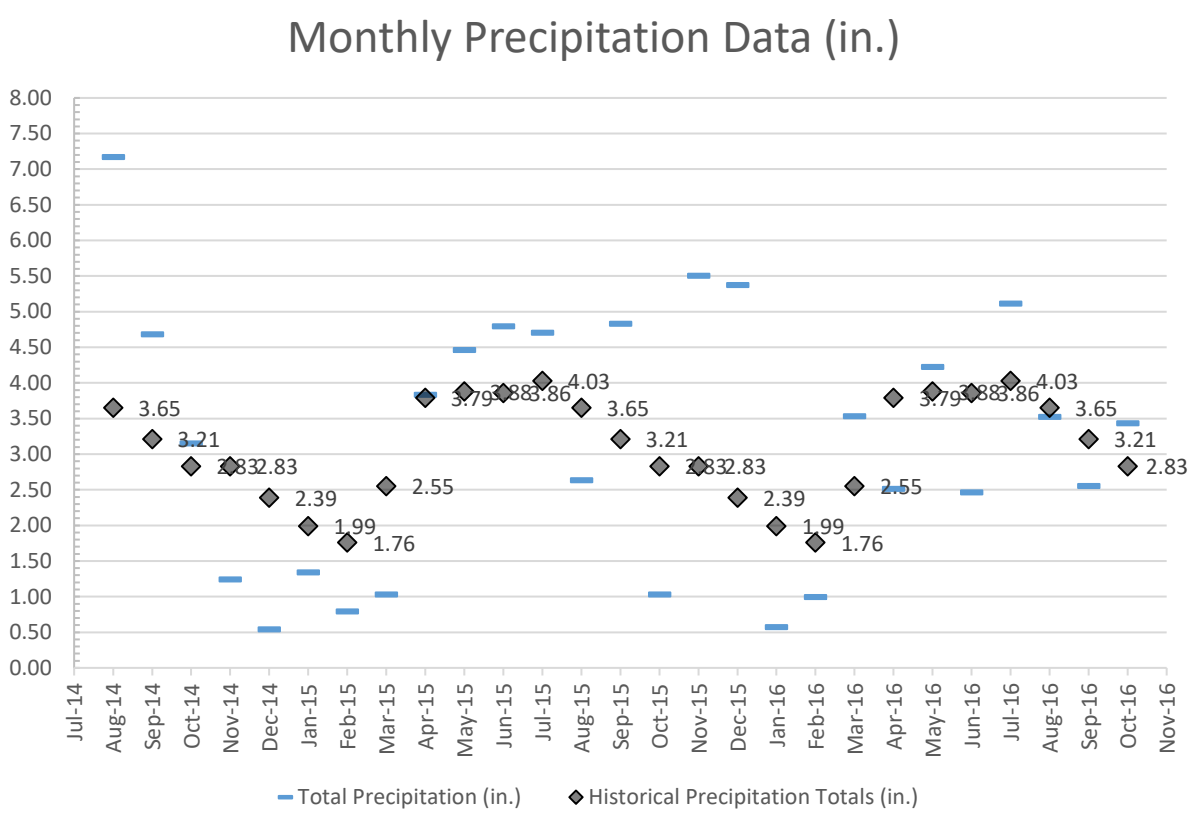
The precipitation and temperature data for the investigation period are compared against thirty-year monthly data (1981 to 2010) illustrate deviations from "normal" climate conditions during the current investigation. Local climatologic data were obtained from the Lake Villa, Illinois Station USC00114837.



A high monthly precipitation of 3.43 inches and high average temperature of 67.0° F was recorded for the month of September and October 2016.

Generally higher than average precipitation and higher than average temperature were recorded for the investigation period.

No significant effects on moisture content and water table data are considered likely due to the low permeability characteristics of the encountered soils. However, groundwater may be affected by seasonal water table fluctuations.



Surface Conditions

Some of the borings were performed within the existing pavement and the surface conditions encountered are summarized in the table below.

The below referenced thicknesses are considered approximate and based on visual observations within the borehole. Pavement and subbase type and thickness may vary between boring locations

Table 2: Surface Conditions Summary

Boring SB – 03 (100 ft West of Cedar Ave to McKinley Avenue)	**Boring SB – 04** (100 ft West of Cedar Ave to McKinley Avenue)	**Boring SB – 05** (100 ft West of Cedar Ave to McKinley Avenue)
Total Thickness = 5 ½ inches **Hot Mix Asphalt = 5 ½ in.** **Subbase Stone = 4 ½ inches**	**Total Thickness = N/A** **Boring performed on grass shoulder**	**Total Thickness = N/A** **Boring performed on grass shoulder**

Boring SB – 06 (Cleveland Avenue to Oak Lane Drive)	Boring SB – 07 (Cleveland Avenue to Oak Lane Drive)	Boring SB – 08 (100 ft West of Cedar Ave to McKinley Avenue)
Total Thickness = 15 inches	**Total Thickness = 12 ¼ inches**	**Total Thickness = 10 inches**
Hot Mix Asphalt = 7 in. **Concrete = 8 in.**	**Hot Mix Asphalt = 4 ¾ in.** **Concrete = 7 ½ in.**	**Hot Mix Asphalt = 2 in.** **Concrete = 8 in.**
Subbase Stone Not Observed	**Subbase Stone Not Observed**	**Subbase Stone Not Observed**

Subsurface Conditions

The general project site (including the land bridge section) is adjacent to a natural lake and is generally underlain by a highly compressible organic PEAT layer for the majority of the land bridge and for a portion of the roadway on subgrade. The PEAT layer was at the surface at one point and was observed to vary in thickness up to 18 feet. Most of the area has been filled in with silty clay soils with varying fill thicknesses up to 13 feet atop the PEAT or other natural soils. Sand layers were also encountered at depth in several locations.

Specific to the RGR, subsurface conditions below any existing topsoil, pavement sections, or undocumented fill, generally consisted of black, dark brown, brown, or gray silty clay soils, brown silty clay of high plasticity, black to dark brown and gray peat, brown silty loam soils, and brown poorly graded fine sand.

The majority of the native subsurface soils encountered within the RGR borings are silty CLAY. Two of the six borings contained a SAND layer and one boring encountered a native LOAM layer. One boring encountered a 10-foot thick PEAT layer just west of the land bridge. This PEAT layer was not encountered in the boring further to the west indicating the deposit may have terminated in this area.

The project site is adjacent to a natural lake and is generally underlain by a highly compressible organic PEAT layer for the majority of the land bridge and for a portion of the roadway on subgrade. The PEAT layer was at the surface at one point and ranges in depth with the thickest section encountered being 18-feet. Most of the area has been filled in with silty clay soils with varying fill thicknesses up to 13 feet atop the PEAT or other natural soils.

See the boring logs in the Appendix for further details of subsurface conditions.

Groundwater Conditions

Groundwater was encountered in most of the borings. The following table summarizes groundwater observations from the field:

Table 3: Groundwater Observation Summary

BORING NUMBER	GROUNDWATER ELEVATION DURING DRILLING (DEPTH BEG*)	GROUNDWATER ELEVATION UPON AUGER REMOVAL (DEPTH BEG*)
SB-03	787.90 ft. (6 ft.)	785.90 ft. (8 ft.)
SB-04	N/A	N/A
SB-05	N/A	786.90 ft. (9 ft.)
SB-06	N/A	N/A
SB-07	785 ft. (7 ft.)**	785 ft. (7 ft.)
SB-08	N/A	N/A

*BEG = Below existing grade
** Elevation at ground surface estimated using Google Earth

It should be noted that fluctuations in the groundwater level should be anticipated throughout the year depending on variations in climatological conditions and other factors not apparent at the time the borings were performed. Additionally, discontinuous zones of perched water may exist within the soils. The possibility of groundwater level fluctuation should be considered when developing the design and construction plans for the project.

EXECUTIVE SUMMARY OF GEOTECHNICAL CONSIDERATIONS

Geotechnical Design and Construction Considerations

The main geotechnical design and construction considerations at this site are:

- In general, the **asphalt thicknesses** ranged between 2 and 7 inches.
- The **subbase stone** was approximately 4 ½ inches in the one boring that it was observed.
- In general, the **concrete thicknesses** ranged between 7 ½ and 8 inches, where observed
- **Undercuts** are recommended for a portion of the proposed roadway by Rubino in addition to IDOT District One's requirement that all new, full depth pavement be supported on a 12-inch improved subgrade layer. See Subgrade Stability Recommendations section for more detailed information.
- It is recommended that the current **IDOT Standard Specifications for Road and Bridge Construction** (SSRBC), Adopted April 1, 2016 as well as the current **IDOT Geotechnical Manual** (December 15, 2015) should be used for the design of this project.

The geotechnical-related recommendations in this report are presented based on the subsurface conditions encountered and Rubino's understanding of the project. Should changes in the project criteria occur, a review must be made by Rubino to determine if modifications to our

recommendations will be necessary.

GENERAL SUBGRADE CONDITIONS

Topsoil Discussion

Rubino recommends a topsoil stripping thicknesses of 12 inches for estimating quantities. The actual need for topsoil removal should be determined in the field.

Prior to construction, the ground surface should be stripped of topsoil, organic matter, including root zone materials, and existing pavement. Rubino recommends that all of the topsoil meeting the requirements of Section 211 of the IDOT Standard Specifications for Road and Bridge Construction that is stripped be stockpiled, sorted, and reused for the proposed landscaping improvements. A plan note containing the stockpile information should be included in the contract documents.

Undocumented Fill Discussion

Undocumented fill and possible fill materials were observed in some of the borings to elevations ranging from about 797.75 to 788.00 feet. The fill materials were generally characterized as either black, brown, and gray LOAM or black and brown silty CLAY. The following table outlines areas where undocumented fill was observed to within the soil borings:

Table 4: Undocumented Fill by Location

LOCATION	UNDOCUMENTED FILL ELEVATION RANGE (FT)
IL Route 132 (SB-03)	792.90 – 791.40
IL Route 132 (SB-05)	795.50 – 792.40
IL Route 132 (SB-06)	797.75 – 795.50
IL Route 132 (SB-07)	790.98 – 788.00
IL Route 132 (SB-08)	797.75 – 795.75

Undocumented fill is defined as fill that has been placed without being documented as to its placed density and moisture content.

Undocumented fill and possible fill materials should be carefully evaluated by proof-rolling and subgrade stability testing per the IDOT Subgrade Stability Manual (2005) at the time of construction to document the in-place consistency of these materials to support the proposed pavement.

Deleterious materials were not observed within the undocumented fill materials during the drilling operations. Deleterious materials could include, but are not limited to, bricks, asphalt, concrete, metal, wood, or other building debris. Although deleterious materials were not encountered in all the undocumented fill materials, this does not eliminate the possibility that deleterious materials could be present within the undocumented fill materials at other locations at the site.

Organic Soils Discussion

Organic soils were observed in one of the borings to elevations ranging from about 788.00 to 778.50 feet. The following table outlines areas where organic soils were observed to within the soil borings:

LOCATION	ORGANIC SOIL ELEVATION RANGE (FT)	ORGANIC LOSS ON IGNITION (L.O.I.%)
IL Route 132 (SB-07)	788.00 – 778.50	10 – 57%

Organic soils can later cause settlement or stability problems. If encountered during construction, Rubino recommends that organic soils be removed and replaced with a compacted and documented engineered fill. Based on known site geology and borings performed for the SGR portion of this project, Rubino expects organic soils to be present at other locations along the project length.

Expansive Soil Discussion

Table 5: Expansive Soils by Location

LOCATION	SOIL DESCRIPTION	ELEVATION RANGE RANGE (FT BEG*)
IL Route 132 (SB-08)	Stiff brown silty CLAY of high plasticity (Possible fill)	797.75 – 795.75 (1 – 3 ½)

*BEG = Below existing grade

Expansive soils were observed in one boring along IL Route 132 at elevations ranging from about 797.75 to 795.75 feet during the drilling operations. There is a possibility that expansive soils could be encountered at other locations on the site. Expansive soils are considered unsuitable for construction due to their tendency to absorb moisture from the ground or atmosphere and swell causing the soils to increase in volume. Soils with Liquid Limits greater than 50% (LL > 50%) may exhibit highly plastic behavior and may be considered to have expansive properties (IDOT Manual 2015).

Where expansive soils are encountered, subgrade treatment options may include, but are not limited to:

- Removal and replacement
- Treatment with additives (such as lime stabilization) to reduce the plasticity of the material
- Surface and subsurface drainage techniques to prevent moisture changes of the soil

Pavement Subgrade Preparation

Rubino recommends that unsuitable soils or deleterious materials be removed from the construction area, as applicable. Unsuitable soils or deleterious materials can be described as, but are not limited to:

- Organic soil / topsoil / plants / trees / shrubs / grass
- Frozen soil
- Existing asphalt or concrete pavement sections
- Concrete curb & gutter

Stripping operations should extend a minimum of 5 feet beyond proposed pavement limits where property limits allow. The geotechnical engineer should be notified if there are property boundary limitations. Stripping operations should be monitored and documented by a representative of the geotechnical engineer at the time of construction

Prior to paving, the prepared subgrade should be proofrolled using a loaded tandem axle dump truck or similar type of pneumatic tired equipment with a minimum gross weight of 9 tons per single axle. Localized soft areas identified should be repaired prior to paving. Moisture content of the subgrade be maintained between -2% and +3% of the optimum at the time of paving. It may require rework when the subgrade is either desiccated or wet.

Areas of low support or soft spots should be tested with either a Static Cone Penetrometer (SCP) or Dynamic Cone Penetrometer (DCP). The results of the DCP or SCP tests should be evaluated according to the IDOT Subgrade Stability Manual (2005), to determine the necessary depth of corrective action.

Any undercuts performed to remove low strength, unsuitable soils should be backfilled with material meeting the IDOT District ONE Aggregate Subgrade Improvement Special Provision (April 1st, 2016).

Subgrade Stability Recommendations

Rubino recommends budgeting for a 6-inch undercut from Station 298+41 to Station 304+00 and a 12-inch undercut from Station 304+00 to Station 305+70 in addition to IDOT District One's requirement that all new, full depth pavement be supported on a 12-inch improved subgrade layer meeting the requirements of the IDOT District ONE Aggregate Subgrade Improvement Special Provision (April 1st, 2016).

LOCATION (LENGTH)	ESTIMATED THICKNESS OF TREATMENT* (INCHES)	TREATMENT WIDTH	RECOMMENDED SUBGRADE TREATMENT	GEOTECHNICAL CONCERNS FOR REMEDIAL ACTION
IL Route 132 (286+50 to 288+90)	N/A	Proposed widening areas	Place biaxial geogrid meeting the IDOT District ONE Geotechnical Reinforcement Special Provision (November 30th, 2010) at the bottom of the aggregate subgrade improvements	Peat Deposit (SB-07)
IL Route 132 (298+41 to 304+00)	6	Entire existing roadway	Remove unsuitable soils and replace/backfill with material meeting the IDOT District ONE Aggregate Subgrade Improvement Special Provision (April 1st, 2016)	High moisture contents, w = 26 - 41 % Expansive soil 10% Organic (SB-03, SB-04, & SB-08)
IL Route 132 (304+00 to 305+70)	12	Entire existing roadway		Low Shear Strength Soils, Q_u = 0.7 tsf High moisture contents, w = 30 % (SB-05)

*Thickness of treatment is in addition to the required 12-inch improved subgrade layer.

The actual need for removal and replacement with Aggregate Subgrade Improvement should be determined in the field at the time of construction by the Geotechnical Engineer or soils inspector. All potentially unstable soils should be tested with a cone penetrometer and treated in accordance with article 301.04 of the IDOT Standard Specifications for Road and Bridge Construction (Adopted January 1, 2016) and the undercut guideline in the IDOT Subgrade Stability Manual (Adopted May 1, 2005). If unsuitable soils are encountered in the field during construction, it is recommended that the soil be removed and replaced with material meeting the District One Aggregate Subgrade Improvement Special Provision. Any material not needed for undercut replacement at the time of construction should be deleted form the contract with no extra compensation to the contractor.

It is recommended to place geotextile fabric at the base of undercut areas where low strength subgrade soils are encountered. The 12 inches of improved subgrade is not considered an undercut, and Rubino does not recommend using it below the proposed 12-inch improved subgrade layer unless it is determined to be necessary to achieve stability by the Geotechnical Engineer or soils inspector at the time of construction. The geotextile fabric should meet the requirements per Article 210 in the IDOT Standard Specifications for Road and Bridge Construction (Adopted January 1, 2016). Any material not needed at the time of construction should be with no extra compensation to the contractor.

There will be a need for two separate Aggregate Subgrade Improvement line items in the Schedule of Quantities (SOQ) included in the design plans:

- **Aggregate Subgrade Improvement 12" (SQ YD)** – This will be used for the 12-inch

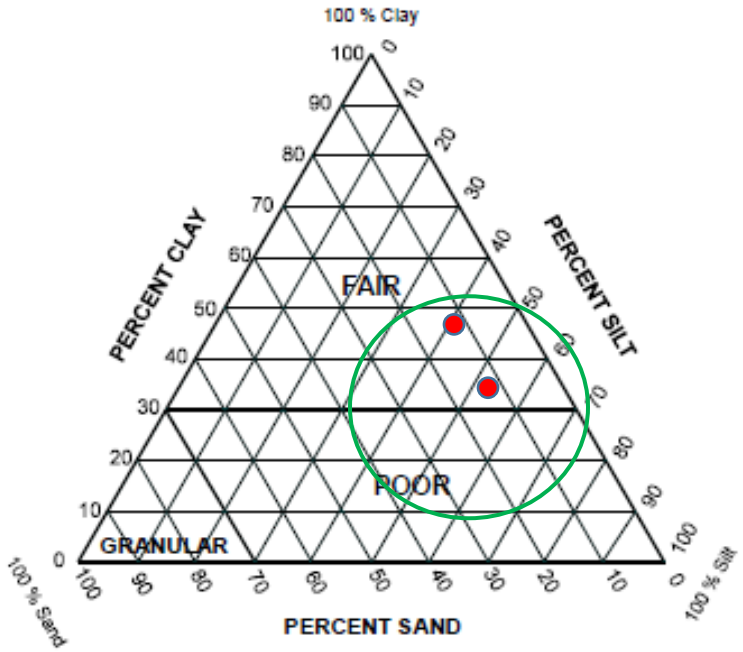
aggregate subgrade improvement below new pavement sections and 3widening pavement sections.

- **Aggregate Subgrade Improvement (CU YD)** – This will be used in locations where there are undercuts (below the 12-inch improved subgrade layer) where poor soils were removed.

Both of these items reference back to the District One Aggregate Subgrade Improvement Special Provision (Adopted April 1, 2016).

Subgrade Support Rating

The soil types throughout the length of the project are varied. For design of the proposed roadway, a Subgrade Support Rating (SSR) of Fair to Poor is indicated based on the laboratory test results. Soil tests indicate soils generally fall within the circled area below. Two data points from laboratory hydrometer testing are presented below as well as included in the Appendices.



Illinois Bearing Ratio

Illinois Bearing Ratio (IBR) testing was outside the scope of this roadway geotechnical report. However, an IBR of 3 should be used for the pavement design based on the laboratory IBR and on an AASHTO M 145 Soil Class of A-4 or A-6. The following table was obtained from the IDOT Geotechnical Manual (2015):

Soil Classification	Assumed IBR
A-1	20
A-2-4, A-2-5	15
A-2-6, A-2-7	12
A-3	10
A-4, A-5, A-6	3
A-7-5, A-7-6	2

Table 6.3.1-1 Estimated IBR Values

The soil types throughout the length of the project are varied and generally include fill soils within the upper three to five feet.

Drainage Class

PROFILE		SOIL TYPE				
Less than 3 ft. of Fill to Less than 6 ft. of Cut	6 ft. or Greater Cut	A-4	A-7-6 (15) to (20)	A-7-6 Less Than (15) or A-6	Fine Sand or Sandy Soil	Gravel and/or Coarse Sand
CROSS SECTION		**MOISTURE CONDITION**				
Ditch 3 ft. or Deeper / Shallow Ditch or Gutter / Ditch 3 ft. or Deeper / Shallow Ditch or Gutter		High Water Table, Very Wet, Wet, Moist, Dry	High Water Table, Very Wet, Wet, Moist, Dry	High Water Table, Very Wet, Wet, Moist, Dry	High Water Table, Very Wet, Wet, Moist, Dry	High Water Table, Very Wet, Wet, Moist, Dry
GRADE		**CLASSIFICATION**				
	Less than 0.5%	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Poor, Fair, Good	Poor, Fair, Good
Less Than 0.5%	0.5% or Greater	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Poor, Fair, Good	Poor, Fair, Good
0.5% or Greater	Less than 0.5%	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Poor, Fair, Good	Poor, Fair, Good
Less than 0.5%	0.5% or Greater	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Poor, Fair, Good	Poor, Fair, Good
0.5% or Greater		Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Very Poor, Poor, Fair, Good	Poor, Fair, Good	Poor, Fair, Good

Fill greater than 3 ft. are classed as good drainage. Moisture rating should be adjusted if other than normal rainfall precedes survey.

(Reproduced from Design Memorandum No. DM 95-8).

Table 6.3.4.1-1 Drainage Classification

Per the IDOT Geotechnical Manual (2015) drainage class descriptions, soils at this site would have a drainage classification of fair to poor. The roadway generally sits in a lower topographic area adjacent to a lake and the permanent water table is generally low (greater than 5-feet) with temporary levels shallower. The table above provides guidance for drainage classification considering soil type, profile grade line, and depth and grade of ditch.

The following table provides the soil erosion factors (K factors), erosion hazard ratings and slope percentages using the Web Soil Survey found on the NRCS website for each of proposed the soil types encountered within the project limits. The NRCS Soil Maps and additional information are in the Appendix.

Table 6: Soil Erosion Factors, Erosion Hazard Ratings and Slope % by Soil Type

MAP UNIT NAME AND SYMBOL	SOIL EROSION FACTOR (K-FACTOR)	EROSION HAZARD RATING	SLOPE PERCENTAGE
IL Route 132 from Cleveland Ave to McKinley Ave			
Pella silty clay loam (153A)	0.24	Slight	0 – 2 %
Beecher silt loam (298A)	0.37	Slight	0 – 2 %
Peotone silty clay loam (330A)	0.24	Slight	0 – 2 %
Saylesville silt loam (370B)	0.43	Moderate	2 – 4 %
Ozaukee silt loam (530C)	0.43	Moderate	4 – 6 %

Fill Materials

Most of the proposed roadway improvements are planned to be constructed at existing grade with cuts and fills less than 2-feet. However, fill discussion is being provided for information purposes and for scenarios when fill materials are required. Once the proposed roadway subgrade has successfully been proof rolled and documented, placement of new structural fill required to establish construction grades may begin. The first layer of fill material should be placed in a relatively uniform horizontal lift and adequately keyed into the subgrade soils

The cut and fill requirements at each boring are estimated in the table below. The values were estimated by comparing ground surface elevations at the location of the soil borings to the Cross Section sheets prepared by ABNA. Where the proposed grade is to be raised and fill materials are required, the fill materials for embankment construction must conform to the requirement of Section 205 of the, “Standard Specifications for Road and Bridge Construction,” adopted by the Illinois Department of Transportation, April 1st, 2016.

Table 7: Summary of Proposed Cut / Fills by Boring Location

LOCATION	BORING NUMBER	EXISTING ELEVATION (FT)	PROPOSED ELEVATION (FT)	FILL (+) OR CUT (-) NEEDED TO REACH PROPOSED GRADE (FT)
IL Route 132	SB-03	793.9	793.67	-0.2
IL Route 132	SB-04	800.10	798.61	-1.5
IL Route 132	SB-05	795.90	795.75	-0.2
IL Route 132	SB-06	799.00*	798.79	-0.2
IL Route 132	SB-07	792.00*	791.30	-0.7
IL Route 132	SB-08	799.00*	797.90	-1.1

*Existing elevation estimated using Google Earth

The most current versions of the "Supplemental Specifications and Recurring Special Provisions" and "Project Procedures Guide" should be referenced for testing frequencies.

Table 6-1
Requirements of Borrow Soils for the Top 600 mm (24 in.) Subgrade.

REQUIRED TEST	AASHTO METHOD	PERMISSIBLE LIMIT
SDD (at OMC)	T 99 (Method C)	1,450 kg/m^3 (90 pcf) min. *
Organic Content	T 194	10 % max.
Percent Silt and Fine Sand	T 88	65 % max. **
PI	T 90	12 % min. **
LL	T 89	50 % max.
Shear Strength (c) at 95 % SDD	T 208 or T 234	50 kPa (1,000 psf) min.***
SO_3****	ASTM C 618	5 % max.

* As per Standard Specifications.
** Frost susceptibility criteria.
*** For engineered embankments which are 4.5 m (15 ft) in height or greater.
**** Only for CCB.

For budget purposes, IDOT typically recommends a shrinkage factor of 15 percent be used to determine earthwork quantities.

Subbase Stone Recommendations

The granular base course should be built at least 2 feet wider than the pavement on each side to support the tracks of the slipform paver. This extra width is structurally beneficial for wheel loads applied at pavement edge.

It is recommended all new pavement is supported on 12 inches of improved subgrade, meeting the requirements of the District One, Aggregate Subgrade Improvement Special Provision (April 1, 2016). An IDOT CA-6 aggregate base (IDOT Specifications Handbook, Sec. 1004.1) can be used under the asphalt or concrete pavements. The material should be placed and compacted as discussed in the Fill Materials section of this report.

Rubino recommends a drainage system be designed to keep water out of the base material since CA-6 contains fines which could become unstable when saturated. The subbase should be graded to drain water fast to mitigate loss of fines through cracks and pavement. See the *Roadway Drainage* section for more information.

Roadway Drainage

Proper surface grading should be incorporated into design and construction of subgrade and pavement to remove water accumulations and prevent ponding of water.

It is recommended to install longitudinal pipe underdrains under the edge of new pavement in widening area, and transverse pipe underdrains below the pavement in low areas and at the base of any undercuts. The underdrains should tie into the storm water drainage system and should be installed per Article 601 in the IDOT Standard Specifications for Road and Bridge Construction (Adopted January 1, 2016) and consist of Type 2 underdrains.

CLOSING

The recommendations submitted are based on the available subsurface information obtained by Rubino Engineering, Inc. and design details furnished by ABNA for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, Rubino should be notified immediately to determine if changes in the foundation recommendations are required. If Rubino is not retained to perform these functions, we will not be responsible for the impact of those conditions on the project.

The scope of services did not include an environmental assessment to determine the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater or air, on, or below or around this site. Any statements in this report and/or on the boring logs regarding odors, colors, and/or unusual or suspicious items or conditions are strictly for informational purposes.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At this time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of ABNA and their consultants for the specific application to the IL Route 132 Dry Land Bridge Roadway Improvements in Lake Villa, Illinois.

APPENDIX A - DRILLING, FIELD, AND LABORATORY TEST PROCEDURES

ASTM D1586 Penetration Tests and Split-Barrel Sampling of Soils

During the sampling procedure, Standard Penetration Tests (SPT's) were performed at regular intervals to obtain the standard penetration (N-value) of the soil. The results of the standard penetration test are used to estimate the relative strength and compressibility of the soil profile components through empirical correlations to the soils' relative density and consistency. The split-barrel sampler obtains a soil sample for classification purposes and laboratory testing, as appropriate for the type of soil obtained.

Water Level Measurements

Water level observations were attempted during and upon completion of the drilling operation using a 100-foot tape measure. The depths of observed water levels in the boreholes are noted on the boring logs presented in the appendix of this report. In the borings where water is unable to be observed during the field activities, in relatively impervious soils, the accurate determination of the groundwater elevation may not be possible even after several days of observation. Seasonal variations, temperature and recent rainfall conditions may influence the levels of the groundwater table and volumes of water will depend on the permeability of the soils.

Ground Surface Elevations

The depths indicated on the attached boring logs are relative to the existing ground surface for each individual boring at the time of the exploration. Ground surface elevations for SB-03, SB-04, & SB-05 were surveyed and provided to Rubino by Accurate Group. Ground surface elevations for SB-06, SB-07, & SB-08 were estimated using Google Earth. Copies of the boring logs are located in the Appendix of this report.

ASTM D2216 Water (Moisture) Content of Soil by Mass (Laboratory)

The water content is an important index property used in expressing the phase relationship of solids, water, and air in a given volume of material and can be used to correlate soil behavior with its index properties. In fine grained cohesive soils, the behavior of a given soil type often depends on its natural water content. The water content of a cohesive soil along with its liquid and plastic limits as determined by Atterberg Limit testing are used to express the soil's relative consistency or liquidity index.

ASTM D2974 Standard Test Method for Organic Soils using Loss on Ignition (Laboratory)

These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks. Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a muffle furnace at 440°C (Method C) or 750°C (Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample. 2.4 Organic matter is determined by subtracting percent ash content from 100.

ASTM D4318 Atterberg Limits (Laboratory)

Atterberg limit testing defines the liquid limit (LL) and plastic limit (PL) states of a given soil. These limits are used to determine the moisture content limits where the soil characteristics changes from behaving more like a fluid on the liquid limit end to where the soil behaves more like individual soil particles on the plastic limit end. The liquid limit is often used to determine if a soil is a low or high plasticity soil. The plasticity index (PI) is difference between the liquid limit and the plastic limit. The plasticity index is used in conjunction with the liquid limit to determine if the material will behave like a silt or clay.

ASTM D422 Particle Size Analysis (Laboratory)

The Particle Size Analysis of Soils determines the distribution of particle sizes in order to further classify the soil. The distribution of particle sizes larger than 75µm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75µm is determined by a sedimentation process, using a hydrometer to secure the necessary data. These soils are then classified more accurately based on the distribution information.

APPENDIX B - REPORT LIMITATIONS

Subsurface Conditions:

The subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the appendix should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratifications, penetration resistances, locations of the samples and laboratory test data as well as water level information. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur, and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition between layers may be gradual. The samples, which were not altered by laboratory testing, will be retained for up to 60 days from the date of this report and then will be discarded.

Geotechnical Risk:

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools that geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free, and more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations, presented in the preceding section, constitute Rubino's professional estimate of the necessary measures for the proposed structure to perform according to the proposed design based on the information generated and reference during this evaluation, and Rubino's experience in working with these conditions.

Warranty:

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

Federal Excavation Regulations:

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document was issued to better insure the safety of workmen entering trenches or excavations. This federal regulation mandates that all excavations, whether they be utility trenches, basement excavation or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person," as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Rubino is providing this information solely as a service to our client. Rubino is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

APPENDIX C - SOIL CLASSIFICATION GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1 3/8" I.D., 2" O.D., unless otherwise noted	PS:	Piston Sample
ST:	Thin-Walled Tube - 3" O.D., Unless otherwise noted	WS:	Wash Sample
PM:	Pressuremeter	HA:	Hand Auger
RB:	Rock Bit	HS:	Hollow Stem Auger
DB:	Diamond Bit - 4", N, B	BS:	Bulk Sample

Standard "N" Penetration: Blows per foot of a 140-pound hammer falling 30 inches on a 2 inch O.D. split spoon sampler (SS), except where noted.

WATER LEVEL MEASUREMENT SYMBOLS:

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of ground water levels is not possible with only short term observations.

DESCRIPTIVE SOIL CLASSIFICATION:

Soil Classification is based on the Unified Soil Classification System as defined in ASTM D-2487 and D-2488. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: clays, if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse grained soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their consistency. Example: Lean clay with sand, trace gravel, stiff (CL); silty sand, trace gravel, medium dense (SM).

CONSISTENCY OF FINE-GRAINED SOILS:

Unconfined Compressive Strength, Qu (tsf)			N-Blows/ft.			Consistency
	<	0.25	< 2			Very Soft
0.25	-	0.5	2	-	4	Soft
0.5	-	1	4	-	8	Medium Stiff
1	-	2	8	-	15	Stiff
2	-	4	15	-	30	Very Stiff
4	-	8	30	+		Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

N-Blows/ft.			Relative Density
0	-	4	Very Loose
4	-	10	Loose
10	-	30	Medium Dense
30	-	50	Dense
50	+		Very Dense

RELATIVE PROPORTIONS OF SAND & GRAVEL

Descriptive Term	% of Dry Weight		
Trace		<	15
With	15	-	29
Modifier		>	30

RELATIVE PROPORTIONS OF FINES

Descriptive Term	% of Dry Weight		
Trace		<	5
With	5	-	12
Modifier		>	12

*Descriptive Terms apply to components also present in sample

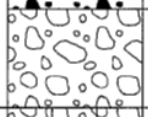
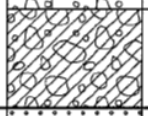
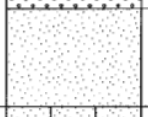
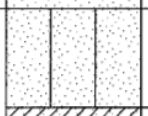
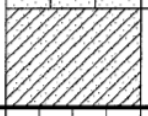
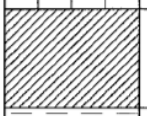
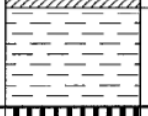
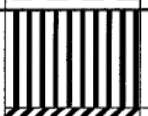
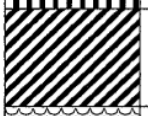
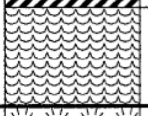
GRAIN SIZE TERMINOLOGY

Major Component	Size Range
Boulders	Over 12 in. (300mm)
Cobbles	12 in. To 3 in. (300mm to 75mm)
Gravel	3 in. To #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75mm to 0.75mm)

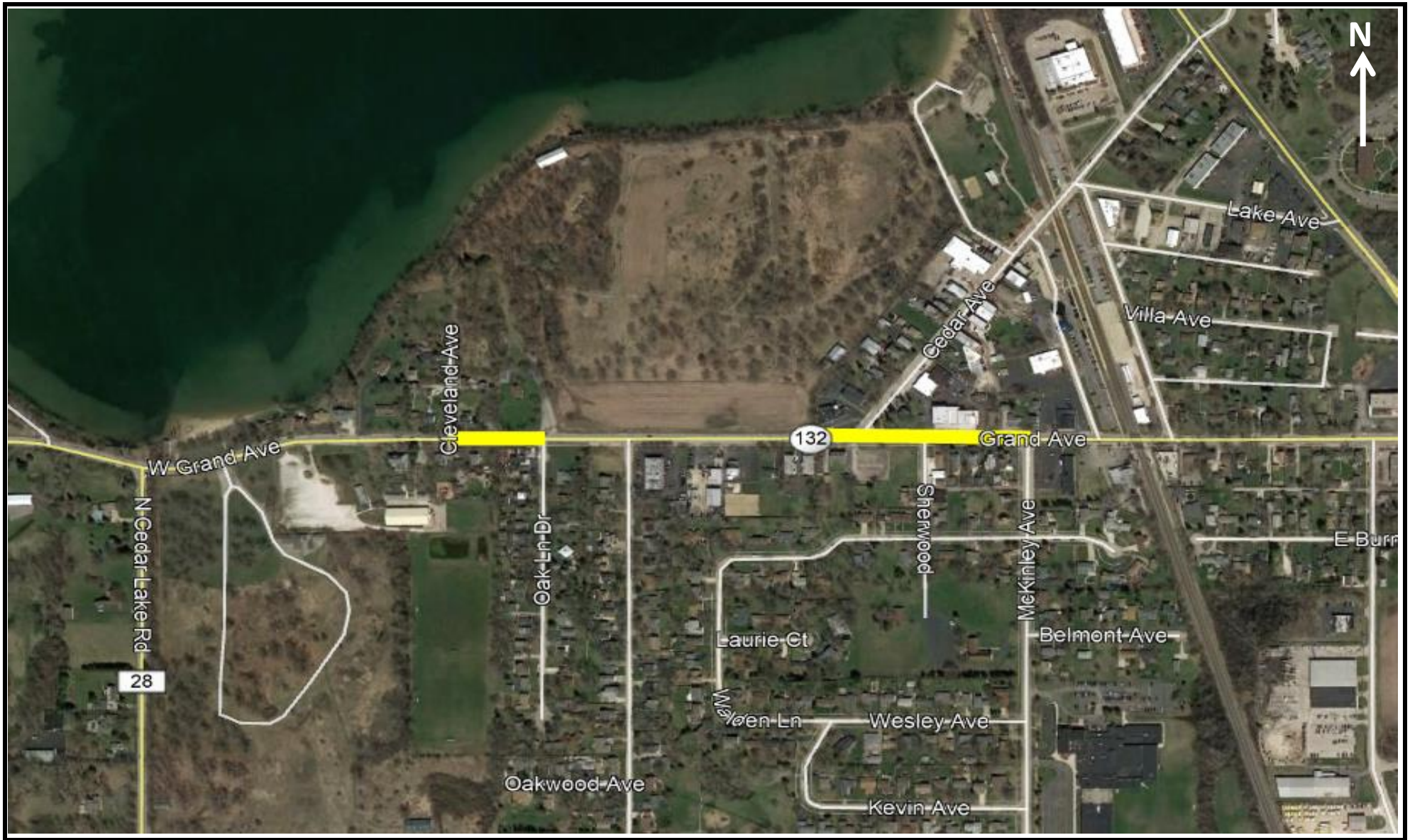
APPENDIX D - SOIL CLASSIFICATION CHART

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

APPENDIX E – SITE VICINITY MAP & BORING LOCATION PLAN



rubino ENGINEERING INC.

665 Tollgate Rd. Unit H
Elgin, Illinois 60123

Project Name:	IL Route 132 Dry Land Bridge-Additional Borings
Project Location:	IL Route 132 - Cleveland Ave to McKinley Ave Lake Villa, Illinois
Client:	ABNA Engineering, Inc.
Rubino Project # :	G16.099

Site Vicinity Map

rubino ENGINEERING INC.

665 Tollgate Rd. Unit H
Elgin, Illinois 60123

Project Name:	IL Route 132 Dry Land Bridge-Additional Borings
Project Location:	IL Route 132 - Cleveland Ave to McKinley Ave Lake Villa, Illinois
Client:	ABNA Engineering, Inc.
Rubino Project # :	G16.099

Boring Location Plan (1 of 2)

rubino ENGINEERING INC.

665 Tollgate Rd. Unit H
Elgin, Illinois 60123

Project Name:	IL Route 132 Dry Land Bridge-Additional Borings
Project Location:	IL Route 132 - Cleveland Ave to McKinley Ave Lake Villa, Illinois
Client:	ABNA Engineering, Inc.
Rubino Project # :	G16.099

Boring Location Plan (2 of 2)

APPENDIX F – BORING LOGS

rubino ENGINEERING INC.

SOIL BORING LOG

Date 9/30/16

ROUTE IL 132 / Grand Avnenue **DESCRIPTION** Phase II design services for IL 132 from Oak Lane Drive to McKinley Avenue on IL Rt. 132 **LOGGED BY** D.K.

SECTION WR(2)-R-1 **LOCATION** Cleveland Avenue to McKinley Avenue

COUNTY Lake County **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** Automatic

STRUCT. NO. Land Bridge
Station N/A

BORING NO. SB-03
Station 299+00
Offset 23N of CL
Ground Surface Elev. 793.90 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 6 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** 8 ft ▽

		DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Approximately 5½ inches of ASPHALT	793.44				
Approximately 4½ inches of sandy GRAVEL BASE	792.90				
FILL: Black, brown, and gray LOAM Organic content: 10%			2 2 3		41
	791.40				
A-6: Medium stiff to stiff brown silty CLAY			3 3 4	1.1 B	17
		-5	4 4 6	2.7 B	15
	787.90 ▼				
A-3: Medium dense brown poorly-graded fine SAND			7 8 9		
			▽		
			8 7 8		
	784.90				
A-6: Stiff to very stiff gray silty CLAY					
	783.90	-10			
End of boring at 10 feet.					
		-15			
		-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 10/4/16

ROUTE IL 132 / Grand Avnenue **DESCRIPTION** Phase II design services for IL 132 from Oak Lane Drive to McKinley Avenue on IL Rt. 132 **LOGGED BY** D.K.

SECTION WR(2)-R-1 **LOCATION** Cleveland Avenue to McKinley Avenue

COUNTY Lake County **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** Automatic

STRUCT. NO. Land Bridge
Station N/A

BORING NO. SB-04
Station 302+00
Offset 53S of CL
Ground Surface Elev. 800.10 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter N/A ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Approximately 12 inches of TOPSOIL				
799.10				
A-6: Stiff to very stiff brown silty CLAY		4 6 6		15
		5 6 10	5.4 B	21
	-5			
		7 7 11	7.4 B	18
		4 7 11	7.4 B	17
790.10	-10			
End of boring at 10 feet.				
	-15			
	-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 10/4/16

ROUTE IL 132 / Grand Avnenue **DESCRIPTION** Phase II design services for IL 132 from Oak Lane Drive to McKinley Avenue on IL Rt. 132 **LOGGED BY** D.K.

SECTION WR(2)-R-1 **LOCATION** Cleveland Avenue to McKinley Avenue

COUNTY Lake County **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** Automatic

STRUCT. NO. Land Bridge
Station N/A

BORING NO. SB-05
Station 306+00
Offset 27N of CL
Ground Surface Elev. 795.90 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter N/A ft
Upon Completion N/A ft
After N/A **Hrs.** 9 ft ▽

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
FILL: Black, brown, and gray LOAM				
		1 1 2	0.7 B	30
792.40				
A-6: Soft to medium stiff brown silty CLAY		2 1 3	2.5 B	26
	-5			
789.90				
A-3: Loose brown poorly-graded fine SAND		3 3 5		
788.65				
A-6: Very stiff gray silty CLAY				
	▽	4 7 9	5.8 B	17
785.90	-10			
End of boring at 10 feet.				
	-15			
	-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 12/6/17

ROUTE IL 132 / Grand Avnenue **DESCRIPTION** Phase II design services for IL 132 from Oak Lane Drive to McKinley Avenue on IL Rt. 132 **LOGGED BY** D.C.

SECTION WR(2)-R-1 **LOCATION** Cleveland Avenue to McKinley Avenue

COUNTY Lake County **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** Automatic

STRUCT. NO. Land Bridge
Station N/A

BORING NO. SB-06
Station 285+50
Offset 5.5 S of CL
Ground Surface Elev. 799.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter N/A ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

		DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Approximately 7 inches of ASPHALT	798.42				
Approximately 8 inches of CONCRETE	797.75				
A-6: Stiff dark brown silty CLAY Possible Fill			2 3 6	2.5 P	16
	795.50				
A-6: Stiff to very stiff brown and gray silty CLAY		-5	4 5 9	4.5 P	16
			5 9 12	4.5 P	16
			4 7 11	4.5 P	17
	789.00	-10			
End of boring at approximately 10 feet below existing grade. No free groundwater encountered during drilling operations.		-15			
		-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 12/6/17

ROUTE IL 132 / Grand Avnenue **DESCRIPTION** Phase II design services for IL 132 from Oak Lane Drive to McKinley Avenue on IL Rt. 132 **LOGGED BY** D.C.

SECTION WR(2)-R-1 **LOCATION** Cleveland Avenue to McKinley Avenue

COUNTY Lake County **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** Automatic

STRUCT. NO. Land Bridge
Station N/A

BORING NO. SB-07
Station 287+50
Offset 5 N of CL
Ground Surface Elev. 792.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 7 ft ▼
Upon Completion 7 ft ▽
After N/A **Hrs.** N/A ft

		DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Approximately 4 ¾ inches of ASPHALT	791.60				
Approximately 7 ½ inches of CONCRETE	790.98				
A-6: Stiff black and brown silty CLAY Possible Fill			3 4 5	2.5 P	16
	788.00		2 2 2		57
Black to dark brown and gray PEAT Organic Content: 10 - 57%		-5			
			0 1 1	0.0 P	233
			1 0 0	0.0 P	122
		-10			
2" silty SAND seam			0 0 1	0.3 P	100
	778.50				
A-6: Soft to medium stiff gray silty CLAY			0 0 0	0.0 P	52
		-15			
3" GRAVEL seam			2 1 2	0.3 P	17
			2 3 4	0.3 P	19
	772.00	-20			

End of boring at approximately 20 feet below existing grade.

-25 -30 -35 -40

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 12/6/17

ROUTE IL 132 / Grand Avnenue **DESCRIPTION** Phase II design services for IL 132 from Oak Lane Drive to McKinley Avenue on IL Rt. 132 **LOGGED BY** D.C.

SECTION WR(2)-R-1 **LOCATION** Cleveland Avenue to McKinley Avenue

COUNTY Lake County **DRILLING METHOD** Hollow Stem Auger **HAMMER TYPE** Automatic

STRUCT. NO. Land Bridge
Station N/A

BORING NO. SB-08
Station 303+00
Offset 6 N of CL
Ground Surface Elev. 799.00 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter N/A ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

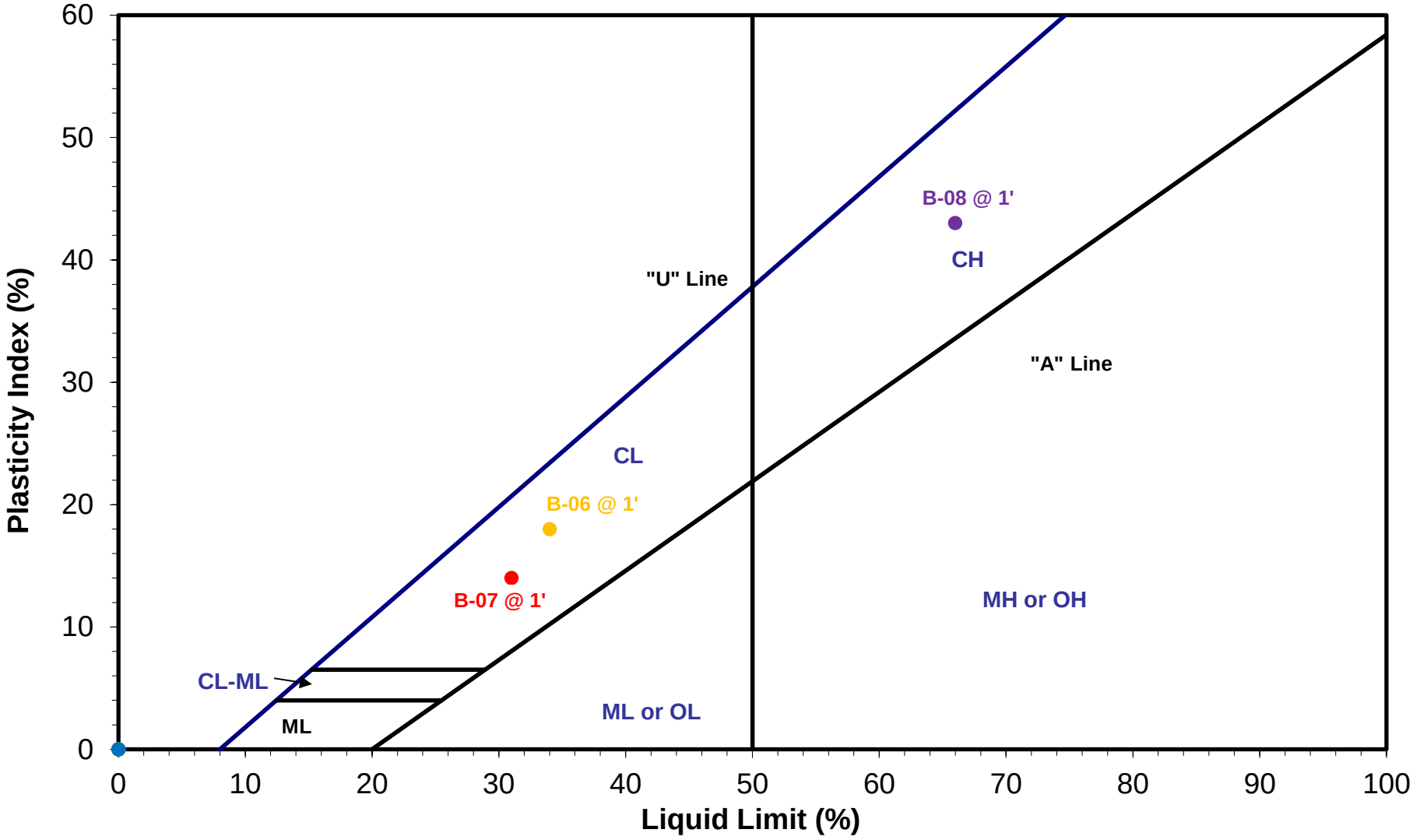
		DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Approximately 2 inches of ASPHALT	798.83				
Approximately 8 inches of weathered CONCRETE	798.17				
A-7-6: Stiff brown silty CLAY of high plasticity Possible fill			2 4 6	3.5 P	26
	795.75				
A-6: Stiff brown and gray silty CLAY			3 5 8	4.0 P	19
		-5			
	792.50		5 7 8	3.0 P	18
A-4: Brown silty LOAM	792.00				
A-6: Stiff brown and gray silty CLAY			5 5 7	2.8 P	15
	789.00	-10			
End of boring at approximately 10 feet below existing grade. No free groundwater encountered during drilling operations.		-15			
		-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

APPENDIX G – LABORATORY RESULTS

rubino ENGINEERING INC.

Report of Atterberg Limits Test (ASTM D4318 / AASHTO T89 / AASHTO T90)

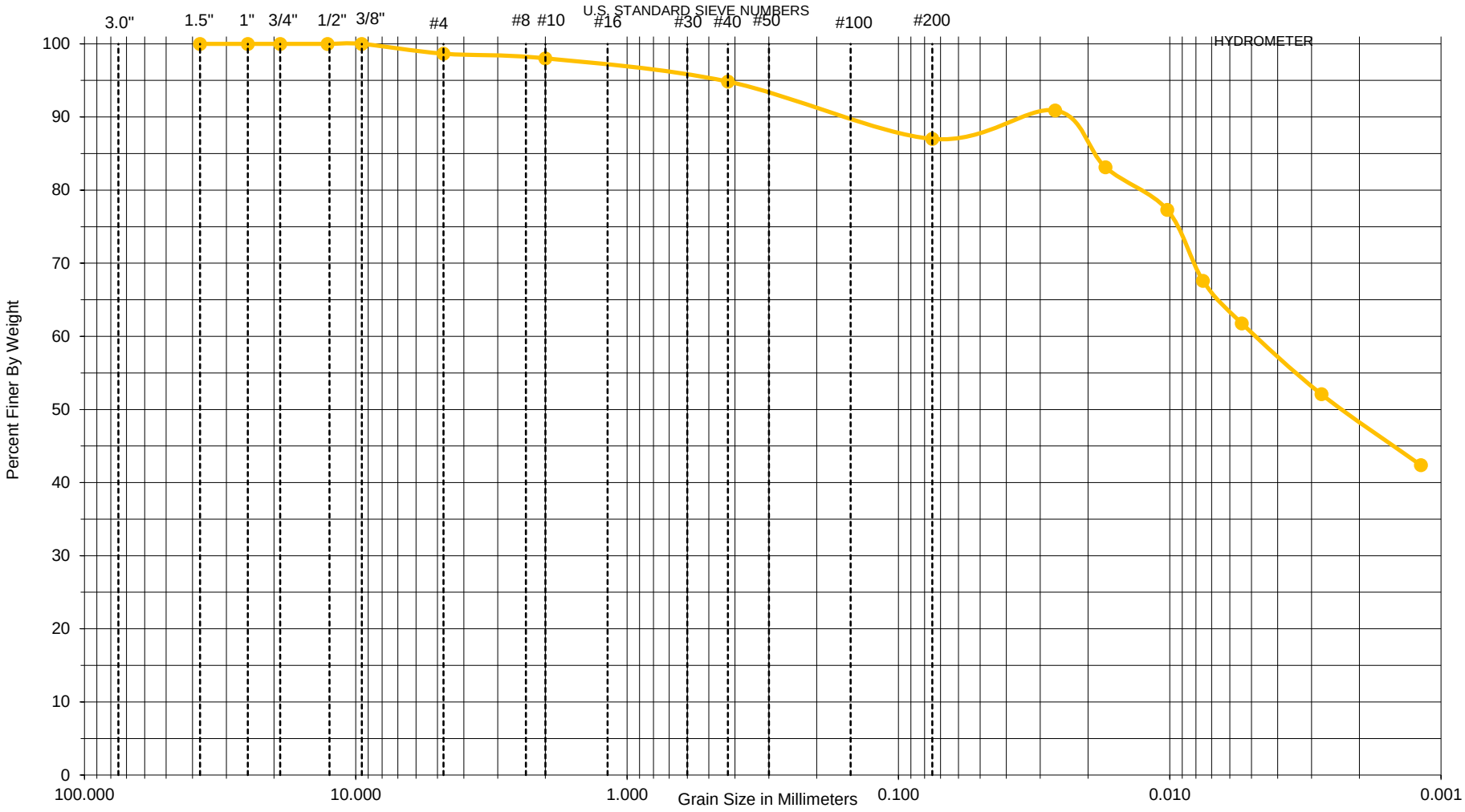


Boring #	B-06 @ 1'	B-07 @ 1'	B-08 @ 1'			
LL	34	31	66			
PL	16	17	23			
PI	18	14	43			

Project: IL Route 132 Dry Land Bridge-Additional Borings
Location: Lake Villa, Illinois
Client: ABNA Engineering, Inc.
Project #: G16.099

rubino ENGINEERING INC.

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



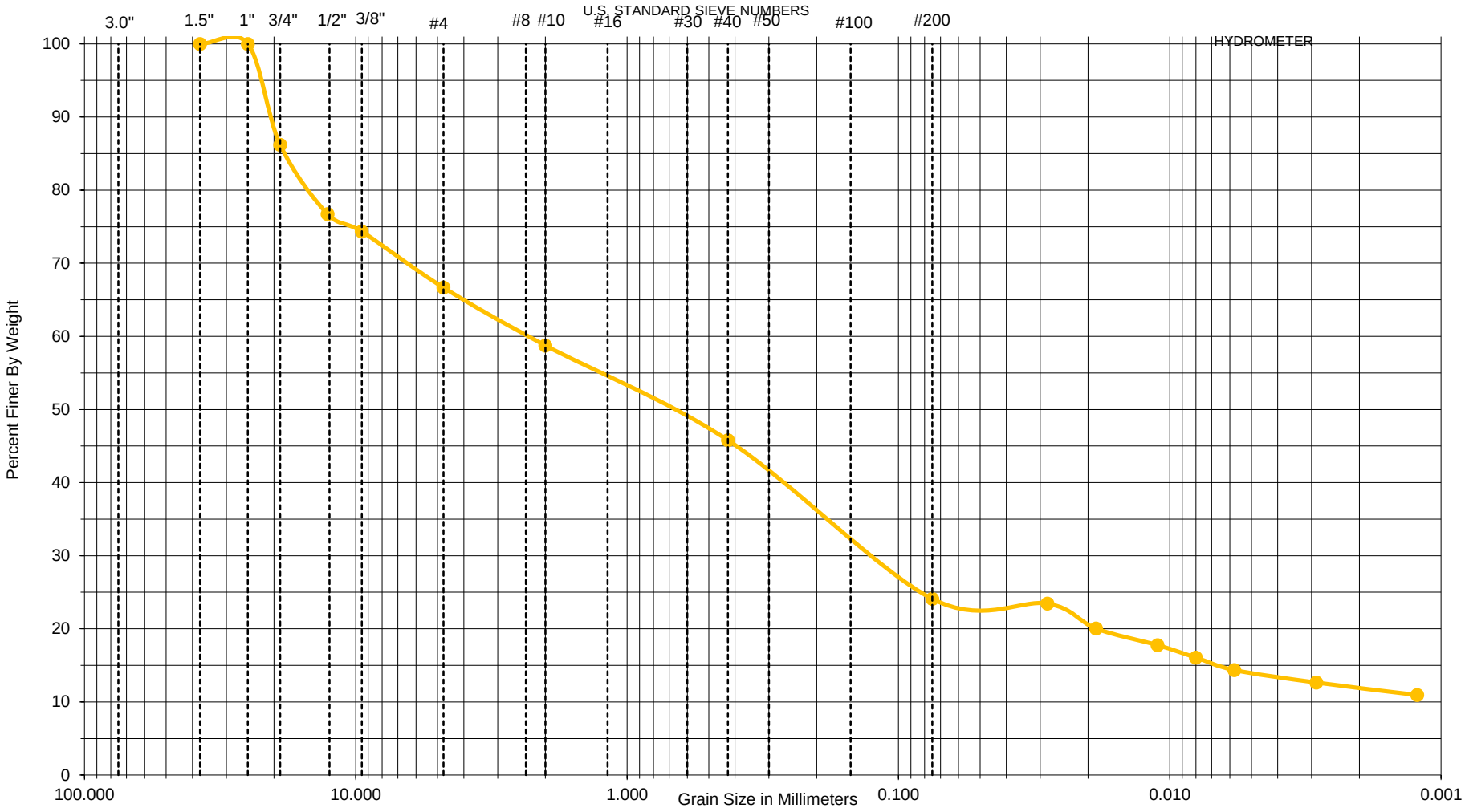
Key	Boring No.	Depth	Soil Description	WC%	ORG%			%Gravel	%Sand	%Silt	%Clay	D60		
●	SB-04	8.5'	(A-6) Silty CLAY	N/A	N/A			1.3	11.7	39.6	47.4	0.005		

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	IL Route 132 Dry Land Bridge	File No. G16.099

Rubino Engineering Inc ● 665 Tollgate Rd. ● Unit H ● Elgin, IL 60123 ● 847-931-1555 ● 847-931-1560 (Fax)

rubino ENGINEERING INC.

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



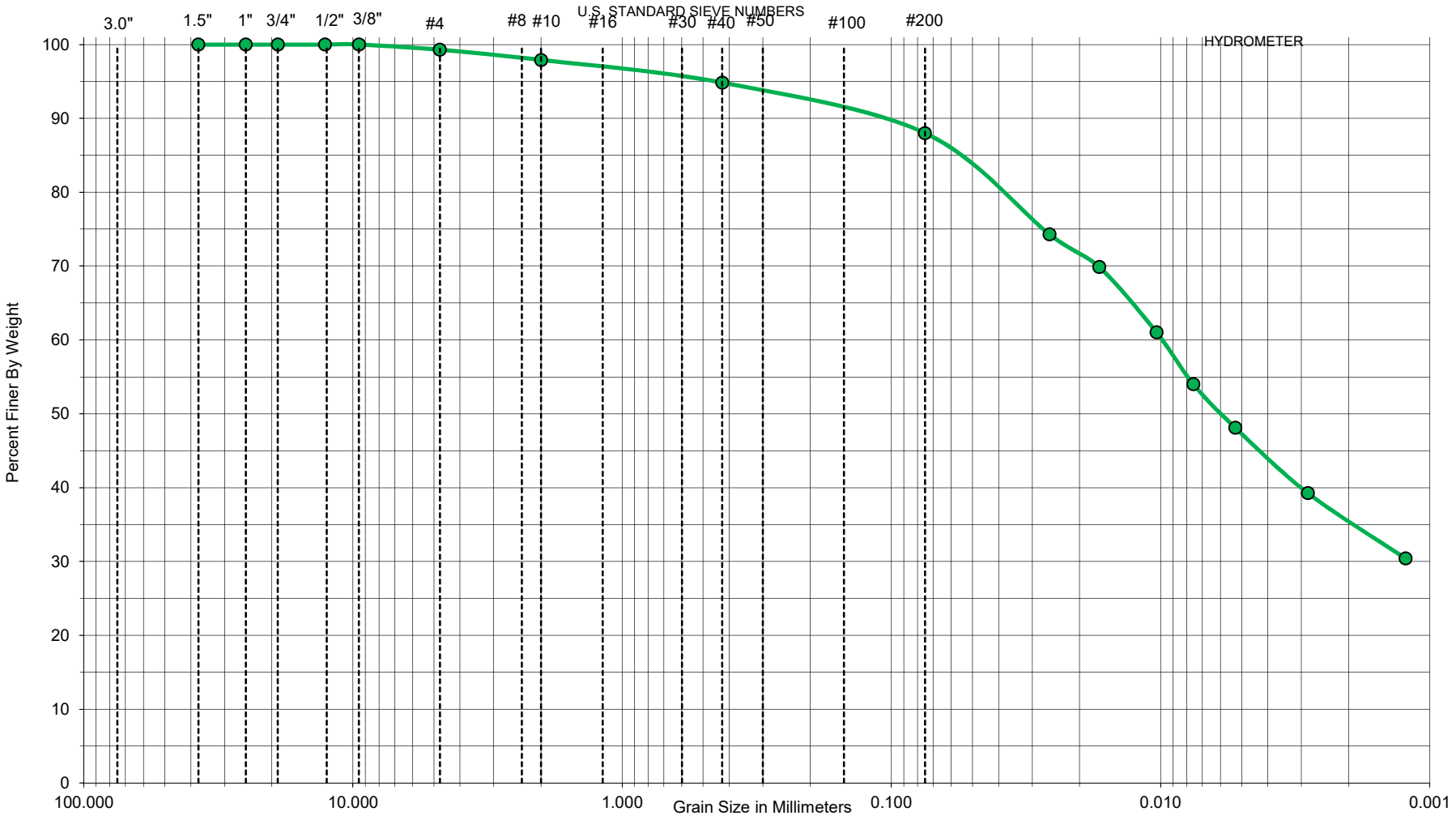
Key	Boring No.	Depth	Soil Description	WC%	ORG%			%Gravel	%Sand	%Silt	%Clay	D60	D30	
●	SB-05	6'	(A-3) Poorly graded fine SAND	N/A	N/A			33.3	42.6	12.4	11.7	2.434	0.170	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	IL Route 132 Dry Land Bridge	File No. G16.099

Rubino Engineering Inc ● 665 Tollgate Rd. ● Unit H ● Elgin, IL 60123 ● 847-931-1555 ● 847-931-1560 (Fax)

rubino ENGINEERING INC.

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



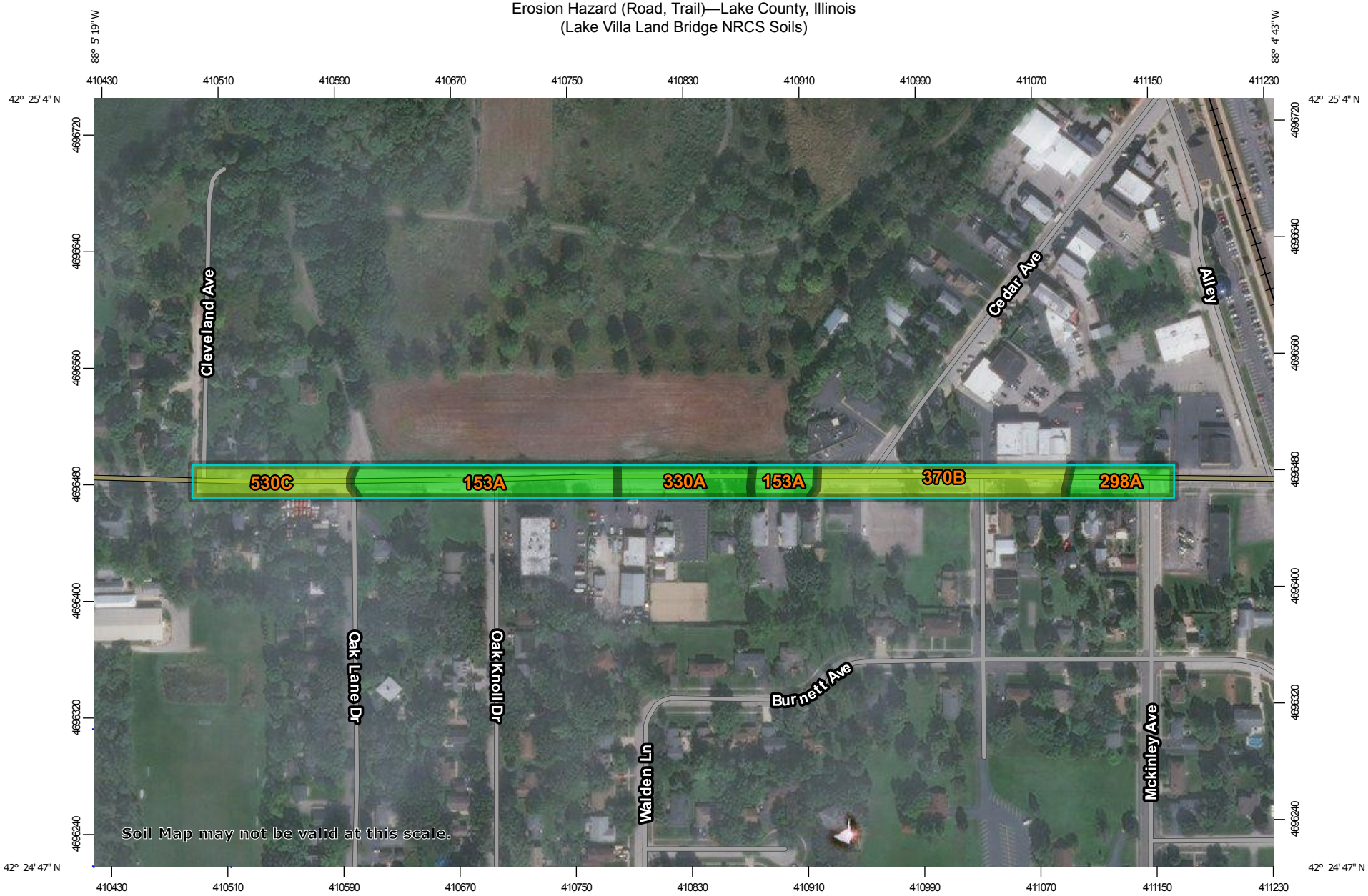
Key	Boring No.	Depth	Soil Description	WC%	ORG%			%Gravel	%Sand	%Silt	%Clay	D60		
●	SB-06	3.5'	(A-6) Silty CLAY	16	N/A			0.7	11.3	53.4	34.6	0.010		

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	IL Rt. 132 Dry Land Bridge, Lake Villa, Illinois	File No. G16.099

Rubino Engineering Inc ● 665 Tollgate Rd. ● Unit H ● Elgin, IL 60123 ● 847-931-1555 ● 847-931-1560 (Fax)

APPENDIX – NRCS SOIL MAPS

Erosion Hazard (Road, Trail)—Lake County, Illinois
(Lake Villa Land Bridge NRCS Soils)



Map Scale: 1:3,720 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Very severe
- Severe
- Moderate
- Slight
- Not rated or not available

Soil Rating Lines
- Very severe
- Severe
- Moderate
- Slight
- Not rated or not available

Soil Rating Points
- Very severe
- Severe
- Moderate
- Slight
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lake County, Illinois
Survey Area Data: Version 12, Oct 1, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 3, 2011—Oct 22, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Erosion Hazard (Road, Trail)

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
153A	Pella silty clay loam, 0 to 2 percent slopes	Slight	Pella, drained (96%)		1.3	33.5%
			Harpster, drained (3%)			
298A	Beecher silt loam, 0 to 2 percent slopes	Slight	Beecher (90%)		0.4	10.8%
			Ashkum (4%)			
			Orthents, clayey (3%)			
330A	Peotone silty clay loam, 0 to 2 percent slopes	Slight	Peotone, drained (95%)		0.5	13.7%
370B	Saylesville silt loam, 2 to 4 percent slopes	Moderate	Saylesville (92%)	Slope/erodibility (0.50)	1.0	25.7%
			Orthents, clayey (2%)	Slope/erodibility (0.50)		
530C	Ozaukee silt loam, 4 to 6 percent slopes	Moderate	Ozaukee (96%)	Slope/erodibility (0.50)	0.6	16.3%
			Orthents, clayey (2%)	Slope/erodibility (0.50)		
Totals for Area of Interest					**3.8**	**100.0%**

Rating	Acres in AOI	Percent of AOI
Slight	2.2	58.0%
Moderate	1.6	42.0%
Totals for Area of Interest	**3.8**	**100.0%**

Description

The ratings in this interpretation indicate the hazard of soil loss from unsurfaced roads and trails. The ratings are based on soil erosion factor K, slope, and content of rock fragments.

The ratings are both verbal and numerical. The hazard is described as "slight," "moderate," or "severe." A rating of "slight" indicates that little or no erosion is likely; "moderate" indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and "severe" indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

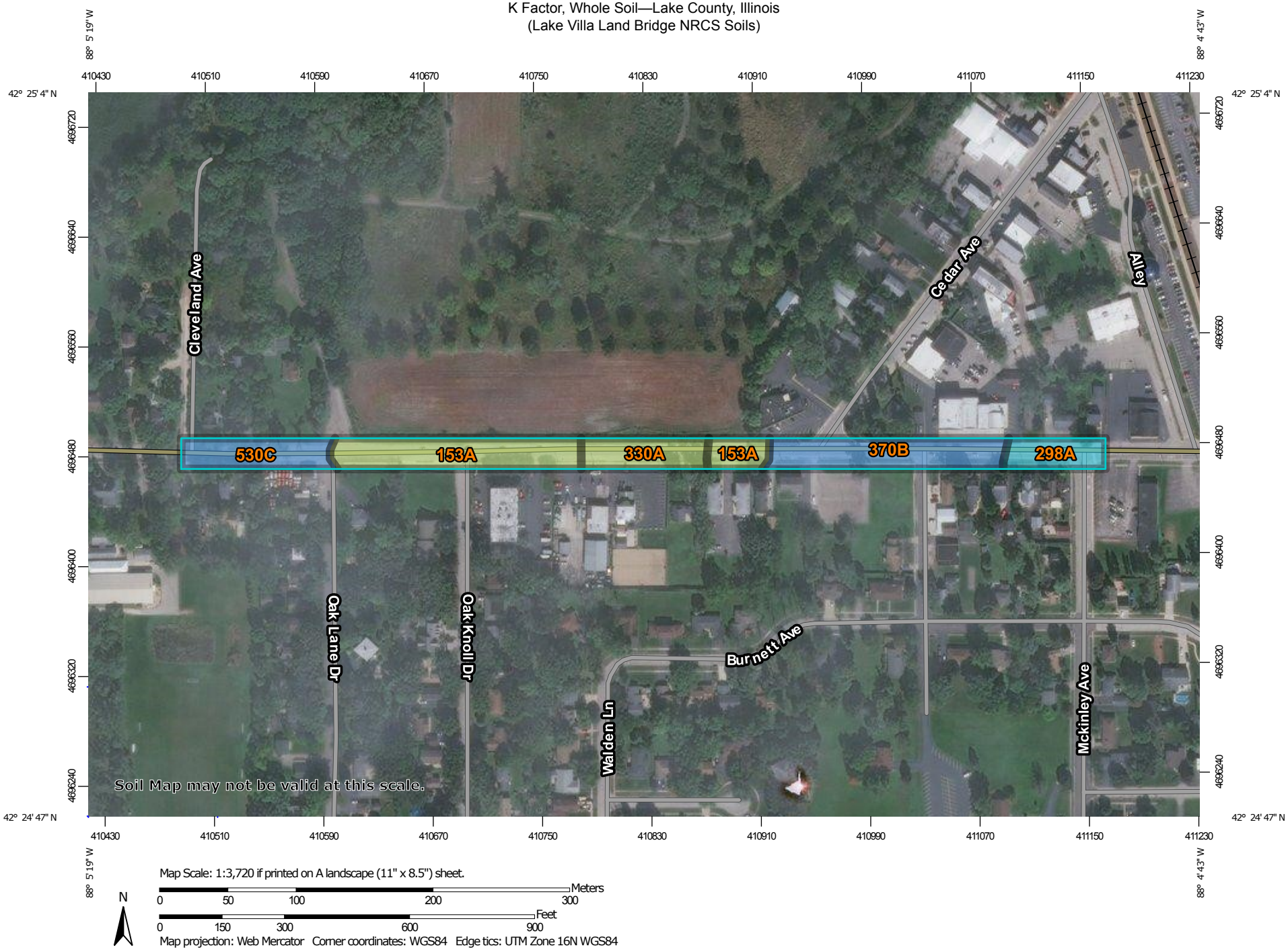
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

K Factor, Whole Soil—Lake County, Illinois
(Lake Villa Land Bridge NRCS Soils)



Map Scale: 1:3,720 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Lines
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Points
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lake County, Illinois
Survey Area Data: Version 12, Oct 1, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 3, 2011—Oct 22, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

K Factor, Whole Soil

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
153A	Pella silty clay loam, 0 to 2 percent slopes	.24	1.3	33.5%
298A	Beecher silt loam, 0 to 2 percent slopes	.37	0.4	10.8%
330A	Peotone silty clay loam, 0 to 2 percent slopes	.24	0.5	13.7%
370B	Saylesville silt loam, 2 to 4 percent slopes	.43	1.0	25.7%
530C	Ozaukee silt loam, 4 to 6 percent slopes	.43	0.6	16.3%
Totals for Area of Interest			**3.8**	**100.0%**

Description

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)